



## Filing Receipt

**Received - 2021-08-16 01:10:14 PM**  
**Control Number - 52373**  
**ItemNumber - 17**

**PROJECT NO. 52373**

**REVIEW OF WHOLESALE  
ELECTRIC MARKET DESIGN**

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**PUBLIC UTILITY COMMISSION  
OF TEXAS**

**COMMENTS OF FORM ENERGY**

Form Energy files these comments in response to the request of the Public Utility Commission of Texas on August 2, 2021.

**EXECUTIVE SUMMARY**

Multi-day energy storage systems have the potential to simultaneously improve the near and long-term reliability of the Texas electric grid, increase the value of the existing transmission system, and support the state's economic development interests. Form Energy is bringing a new class of multi-day energy storage to the market — an iron-air battery that can discharge continuously for 100 hours — to address the specific reliability needs Texas faces, now common in nearly every region of the U.S.: 1) additional flexible resources to balance both the hourly variability of renewable energy resources and the variability that occurs during multi-day weather events; 2) clean alternatives to thermal power plants that can face outages and fuel supply shortages during extreme weather, and whose operations are increasingly constrained by air pollution limits; and 3) rapidly-deployable solutions to grid congestion and renewable energy curtailment until new transmission lines are built.

Texas can face its grid reliability challenges with three actions: defining a clear problem statement, designing targeted market enhancements to address defined needs, and encouraging new resource development to meet grid needs. Form Energy's comments offer initial recommendations, supported by information about the services multi-day storage can provide:

- Define Resource Performance Needed: The Commission should assess new reliability services based on what resource performance is needed to support long-term grid reliability over a range of reliability risks. This need is likely to vary both seasonally and over years. To establish this need, we recommend that the Commission examine the frequency and duration of multi-day renewable energy lulls, multi-day demand peaks, and the coincident occurrence of multi-day renewable energy lulls and scheduled thermal plant outages. The Commission should consider the likelihood of these events occurring as frequently as once in at least ten years, and perhaps as frequently as once in twenty years or more.
- Establish New Reliability Services to Address Multi-Day Reliability Risks: The Commission should explore needs for new reliability services that compensate resources for being firm (i.e. highly available) during multi-day weather events and multi-day reliability risks that can occur in all seasons.
- Ensure Competition: The Commission should ensure that a variety of resources can compete to provide reliability services based on the performance they deliver, including stand-alone multi-day energy storage systems and firm renewable energy resources enabled by on-site or remote energy storage.

These actions can help spur the development of new multi-day energy storage projects and firmed renewable energy projects that can cost-effectively improve grid reliability in Texas.

## **COMMENTS**

### **1. Introduction**

#### **a. About Form Energy**

Form Energy (“Form”) is developing a new class of multi-day energy storage systems to enable a clean electric grid that’s reliable and cost-effective year-round, even in the face of multi-

day weather events. Our first commercial product is a rechargeable iron-air battery capable of continuously discharging electricity for 100 hours at system costs competitive with conventional power plants and at less than 1/10th the cost of lithium-ion battery storage. Our first project is a 1 MW / 150 MWh pilot with Minnesota-based utility Great River Energy that will deploy in 2023 using the repeatable and scalable building block of our system. This project will demonstrate how Form Energy's multi-day energy storage can firm renewable generation assets and provide reliability during multi-day weather events when fossil resources would otherwise be needed to maintain grid reliability. Form is headquartered in Somerville, MA, with offices in the San Francisco Bay Area and the Greater Pittsburgh area. We have secured over \$300M in funding from impact-oriented investors with deep expertise in global infrastructure development, electric grid operations, and manufacturing.

#### **b. Role of Multi-Day Storage in Supporting a Reliable, Cost-Effective Grid**

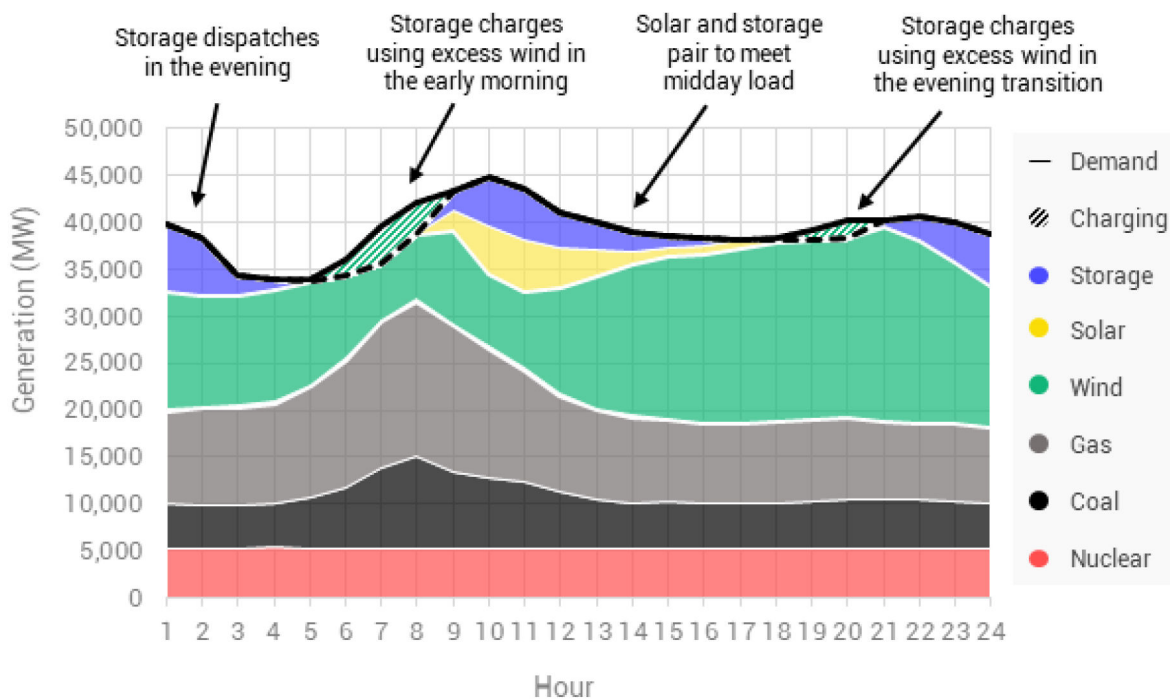
Emerging multi-day energy storage (MDS) resources are firm, dispatchable, and clean. Multi-day energy storage is a diverse resource class that includes iron-air batteries like Form Energy's, as well as other novel battery technologies, thermal storage, hydrogen energy storage, compressed air energy storage, and other technologies. All are capable of firming renewable energy resources, providing reliability when thermal resources are off-line for maintenance, acting as clean dispatchable resources capable of replacing legacy resources, and improving grid resilience at the regional and local level. Multi-day storage is a direct substitute for both infrequently used gas peaker plants and frequently used combined cycle gas power plants.

#### **i. Firming renewable energy resources hourly and across multiple days**

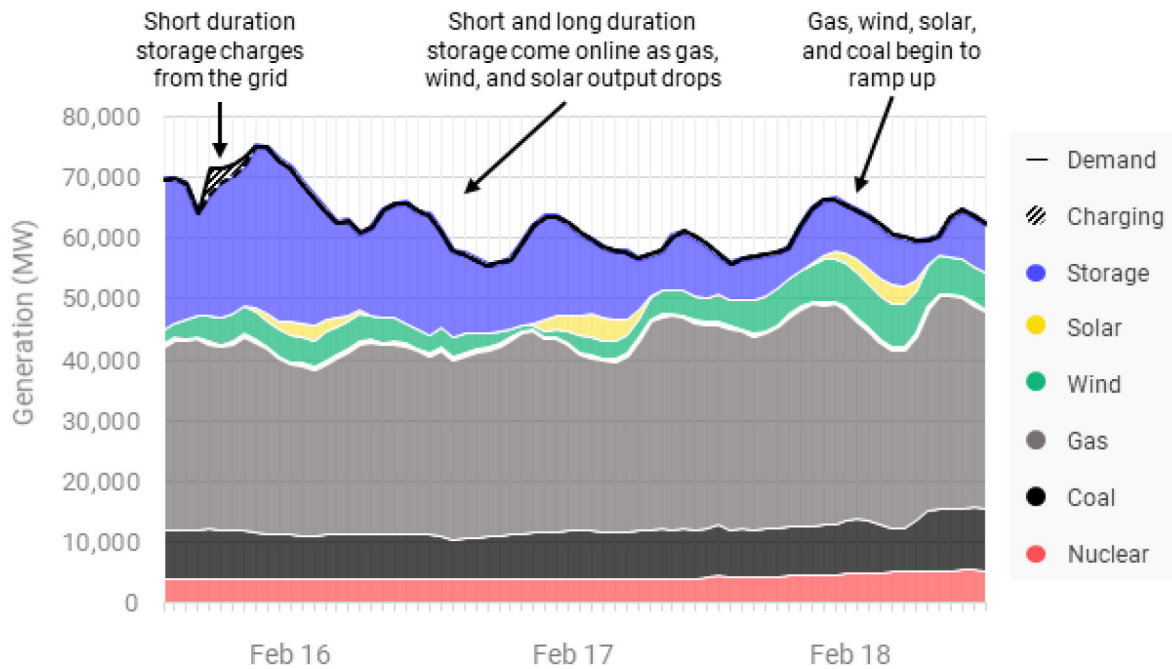
Multi-day energy storage can provide dual functions: it can help balance the hourly variability of renewable energy generation and energy demand (*Figure 1* below), and during

atypical weather events (*Figure 2* below), it can provide multiple days to weeks of zero-carbon energy reserves without recharging. Multi-day storage can shape renewable energy output to meet any load profile, including flexible ramping capacity to address the operational challenges posed by “duck curve” or other net load shapes that require fast-ramping resources in the morning or early evening.

*Figure 1: Typical ERCOT grid operation, February, to simulate hourly storage charge and discharge patterns (in lieu of imports) to shift excess renewables to meet demand peaks*



*Figure 2. ERCOT grid operation during Winter Storm Uri, February 2021, to simulate multiple days of storage portfolio discharge that could have met anticipated demand*

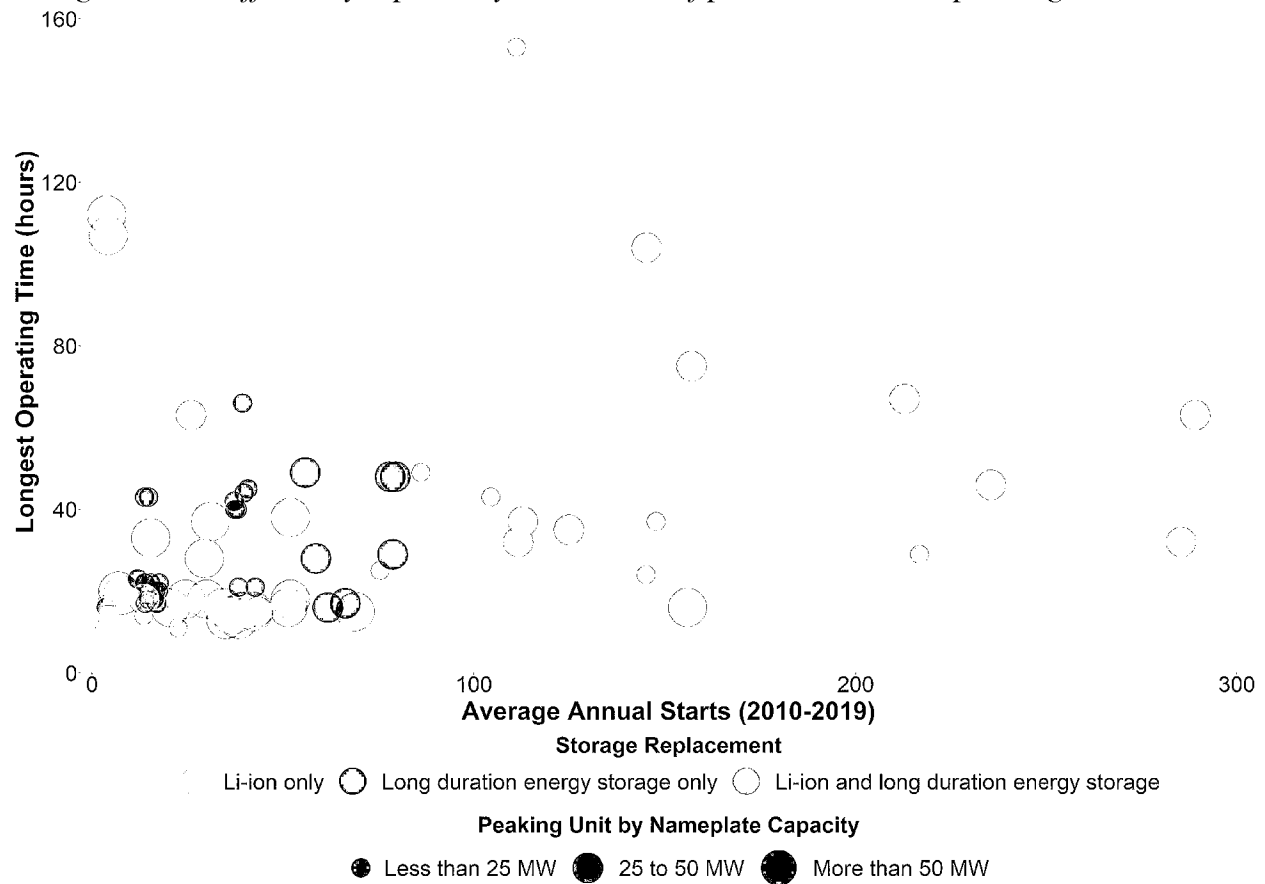


## **ii. Providing clean dispatchable power to maintain reliability**

Today, thermal resources provide the majority of the flexibility and load-following reliability services that the grid needs, although they have no ability to store and shift excess renewable generation. Multi-day storage can cost-effectively replace the reliability functions of flexible natural gas power plants whether multi-day storage is paired with wind or solar resources or operates in a stand-alone configuration.

It is in Texas's economic interest to pursue clean sources of flexibility and reliability services like multi-day battery energy storage. By giving preference to resources that support grid reliability without increasing electric sector air pollution, Texas can preserve opportunities for economic growth along the Gulf Coast, which could become constrained if the Commission encourages electric grid investments that increase demand for limited air pollution allowances.

Figure 3. Natural gas peakers plants in New York State that combinations of li-ion and multi-day storage can cost-effectively replace, by distribution of peaker starts and operating duration<sup>1</sup>



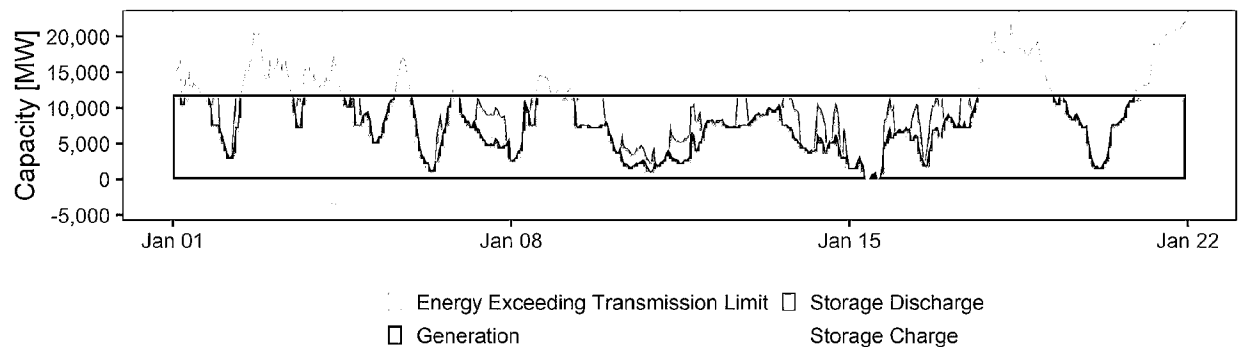
### iii. Maximizing the value of the existing transmission system

Low-cost, multi-day energy storage also can improve the value of the existing transmission grid by reducing uneconomic renewable energy curtailment, reducing transmission grid congestion, and increasing the total amount of low-cost renewable energy that flows across transmission boundaries. Lithium-ion storage can provide some of these benefits, but as renewables continue to expand, particularly in wind-rich regions, mismatches between supply, demand, and transmission capacity can extend for multiple days at a time, which requires multi-

<sup>1</sup> See Form Energy's whitepaper, [Solving the Clean Energy and Climate Justice Puzzle](#): How multi-day storage can cost-effectively replace long-running peakers in New York State.

day storage to address cost-effectively. *Figure 4* illustrates how multi-day storage can increase the overall utilization of renewable resources in regions with transmission constraints.

*Figure 4. Optional hourly operations of multi-day storage in the UK during multi-day congestion events, January 2030<sup>2</sup>*



## 2. Responses to Commission Questions

### a. Question 3: Needs for Ancillary and Reliability Services to Ensure Reliability under Extreme Conditions

Form Energy recommends that the Commission and ERCOT work to develop a new reliability service that will ensure there is a high degree of availability during multi-day periods of renewable energy lulls, extreme weather and other extended grid contingencies likely to occur.

#### i. Recommended Steps to Identify Reliability Service Needs in Texas.

##### 1. Define and characterize reliability risks

The ERCOT grid and others around the country were designed to meet single-day demand peaks with thermal generation resources that were presumed to be available under any grid conditions. However, the grid has changed in recent years: renewable energy resources have rapidly proliferated in Texas; atypical weather events are becoming increasingly common; and both generation and load are affected by weather.

<sup>2</sup> From a forthcoming Form Energy study of the UK transmission grid.



Multiple long-term reliability studies in other states point to a shift in reliability risks: grids must ensure reliability not only during summer peaks but increasingly during winter periods of extreme cold, during renewable energy lulls, and during traditional “shoulder” seasons when thermal resources schedule maintenance and renewable energy lulls can also occur. Reliability challenges now have two dimensions: grids must satisfy single day net demand peaks, and they must also maintain energy sufficiency during multi-day periods of generation scarcity.

In order for the Commission and ERCOT to adopt meaningful reforms that will increase the ability to provide reliable electric service to Texans, ERCOT should conduct a study to characterize multiple operational risks the grid will need to address and to evaluate how these risks may change over seasons and years. These risks include at minimum: 1) Flexible ramping needs to meet net peak load; 2) Multi-day renewable energy lulls; 3) Multi-day periods of high demand and extreme temperature; and, 4) Planned fossil outages in spring and fall.

We recommend that the Commission and ERCOT examine multiple years of weather data, not only typical or average years. This study should be designed to help the Commission understand the magnitude and duration of reliability risks that will occur as frequently as once in at least 10 years. To account for increasingly uncertain weather patterns, we think it is prudent to study weather events and reliability risks that are likely to occur at least once in 20 years.

## **2. Characterize resource needs**

The study we recommend above will give the Commission and ERCOT a basis to assess whether existing resources and markets can support reliability needs today and in the future. *Figure 2* above is one way to characterize a known resource gap that emerged during Winter Storm Uri; however, the Commission should conduct a fuller analysis of each known condition when reliability risks are highest so it can identify unmet resource needs. This will help the Commission

define a target reliability standard (e.g. tolerable loss of load hours or unserved energy) that can serve as the basis for specifying aggregate total amounts of resources, reserve margins, or resource performance needed to achieve Texas’s reliability goals. The Commission can then define market mechanisms to compensate resources for providing needed services.

### **3. Characterize resource performance needed**

The solution to Texas’s reliability challenges and those around the country is the same: add more clean, firm, dispatchable capacity to the grid, and firm up resources that already exist. Unfortunately, no regulator has yet defined the meaning of “firm,” and there are many unresolved questions nationally about how to value the contribution of emerging resources — hybrid resources and long-duration storage generally — toward grid reliability needs.

We recommend that the Commission take a first foundational step: define what performance a resource must deliver to fully meet a defined multi-day reliability need. For example, Form Energy conducted a study of the historic frequency and duration of renewable energy lulls in California (defined as a sustained multi-day drop of at least 25% from the historic average), and we found that 50-hour lulls occur every year, and 100-hour lulls occur at least once every 10 years. Based on this analysis, we recommended that, in California’s context, a firm, dispatchable resource should be defined as a resource guaranteed to deliver its contracted capacity for at least 100 continuous hours if called upon any day of the year.<sup>3</sup> This kind of analysis could help ERCOT evaluate the extent to which diverse hybrid and storage resources contribute to grid needs, and, relatedly, how much the market should compensate them.

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<sup>3</sup> See Form Energy’s [Opening Comments on Administrative Law Judge Ruling Seeking Feedback on Mid-Term Reliability Analysis](#), March 26, 2021, and Form Energy [Opening Comments on Proposed Decision to Address Mid-Term Reliability](#), June 10, 2021, California Public Utilities Commission

#### **4. Identify market mechanisms to compensate for reliability services**

Form Energy recommends that the Commission and ERCOT establish new reliability services to address multi-day reliability risks. The Commission should explore a range of options that compensate resources for being firm (i.e. highly available) during multi-day weather events and multi-day reliability risks that can occur in all seasons. These services could take one of any number of forms that the Commission should weigh, including potentially:

- New reliability reserves to compensate resources for maintaining firm energy supply during multi-day weather events or holding stored energy reserves over defined seasons;
- New ancillary services that pay a premium for “firmness:” an incremental payment based on the degree of availability a resource physically commits for a specified future period;
- Increased performance standards to enhance existing services; or
- New reliability asset contracting to competitively develop new firm resources.

In addition to the criteria laid out in Senate Bill 3, the Commission and ERCOT should ensure that these new products or enhanced services result in increased physical and financial guarantees of availability during the longest multi-day periods of high reliability risks that are likely to occur once in at least ten years. These reliability services should be technology agnostic and should allow participation by stand-alone storage resources and hybrid resources.

#### **3. Conclusion**

Form Energy appreciates the opportunity to provide these comments and looks forward to working with the Commission and other interested parties on these issues.

Respectfully submitted,

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